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LISTS OF SPECIES

Mammals of medium and large size in a fragmented cerrado landscape in northeastern Minas Gerais state, Brazil

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ABSTRACT: The diversity of Brazilian mammals is among the highest of the world. However this exceptional diversity is still widely unknown and great part of it is seriously threatened by human activities. In the present study we estimated species richness and relative abundance of medium and large size mammals for the region of Brasilândia de Minas, a city situated in a fragmented and poorly studied cerrado area of Minas Gerais state, Brazil. We obtained 63 records of 24 species, including eight species threatened with extinction. Our results support the hypothesis that many of the cerrado mammal species may be able to persist in fragmented agricultural landscapes. This paper shows that despite the anthropogenic disturbances detected, the studied area plays an important role in the conservation of medium and large size mammals in the cerrado biome.

INTRODUCTION

Brazil has a high diversity of vertebrates and one of the largest Neotropical mammal fauna (over 650 species) (Reis *et al*. 2006; Pimm *et al*. 2010). Nevertheless, this exceptional diversity is still widely unknown and great part of it is seriously threatened by human activities (Drumond *et al*. 2005; Eduardo and Passamani 2009), especially in regions with high agricultural activity as the Brazilian cerrado (Trolle *et al*. 2007; Lessa *et al*. 2008).

The cerrado biome is a complex mosaic of plant physiognomies ranging from open grassland to closed woodlands (Ratter *et al*. 1997) and occupying almost 49% of the territory of the state of Minas Gerais, Brazil (Drumond *et al*. 2005; Bruna *et al*. 2010). Moreover, the cerrado holds around 13% of the Brazilian mammal diversity (approximately 194 species) (Marinho-Filho *et al*. 2002). Great part of this diversity is endangered since more than 40% of the biome has been converted into agriculture and the remaining is highly fragmented (Klink and Machado 2005; Drumond *et al*. 2005).

Most of the cerrado biome is being destroyed at high rates (Myer *et al*. 2000), leaving behind remnants immersed in a matrix of disturbed vegetation, pastures and crops. The matrix of altered vegetation in which the fragments are immersed can restrain the movements of the animals, change the local composition of species, and produce alterations in the community structure (Fonseca and Robinson 1990; Chiarello 2000; Lyra-Jorge *et al*. 2008). However, some mammal species seem to benefit from agriculture or silviculture expansion (Lyra-Jorge *et al*. 2008).

The study site was considered one of the priority areas for mammal conservation in Minas Gerais State (Drumond *et al*. 2005). However, this is the first field study aiming at the inventory of large to medium-sized mammals of the region of Brasilândia de Minas, which is situated in a highly fragmented and poorly studied cerrado area of Minas Gerais state, Brazil.

MATERIALS AND METHODS

Study area

The study area is located at Três Rios farm (at 16°56'08.96" S, 46°16'05.83" W), approximately 36 km from Brasilândia de Minas, Minas Gerais state, Brazil (Figure 1). The region is characterized by a subtropical climate with two well-defined seasons: a dry cold season (May to September) and a rainy hot season (October to April). The mean annual temperature and precipitation are 22.5°C and 1439 mm, respectively. Três Rios is an 11,973 ha farm where much of the original vegetation has been replaced by pastures and sugar-cane plantations. Nevertheless, typical cerrado physiognomies are still found, such as: 1) savannas with scattered shrubs ('campo sujo'); 2) open canopy woodland with a grassy savanna understory (cerrado *strictu senso*); 3) dense, closed, and semi-closed canopy tall woodland ('cerradão'); and 4) riparian forests ('mata ciliar').

Sampling procedures

Species with representatives weighing between 2 and 7 kg were considered medium size and those weighing more than seven kilograms were considered large size (Emmons and Feer 1997). The taxonomic nomenclature followed Wilson and Reeder (2005).

Some species, (*Didelphis albiventris*, *Callithrix penicillata* and *Sapajus libidinosus*) although not considered medium or large mammals, were included in this study as they could be reliably identified. The local

fauna was surveyed daily for five consecutive days in four field trips, carried out in January, April and June 2010 and February 2011. We applied the following methods: (1) footprint traps (track plots) and (2) searching for mammal signs (*e.g.* direct observations, footprints, feces). Footprint traps were arranged along three trails created by resident farmers in different cerrado physiognomies: cerrado *strictu senso*, cerradão and a transitional area between a riparian forest and the sugar-cane matrix. In each of these physiognomies we set 20 footprint traps (50 X 50 cm) placed at a minimum distance of 10 meters between each other and containing food baits (banana, corn and bacon). In each month, all track plots were checked daily for five consecutive days. Searching for animal signs was conducted along trails and roads crossing the area summing 80 hours of observations in the field. Footprints were identified using field guides (Becker and Dalponte 1991; Emmons and Feer 1997; Carvalho-Junior and Luz 2008).

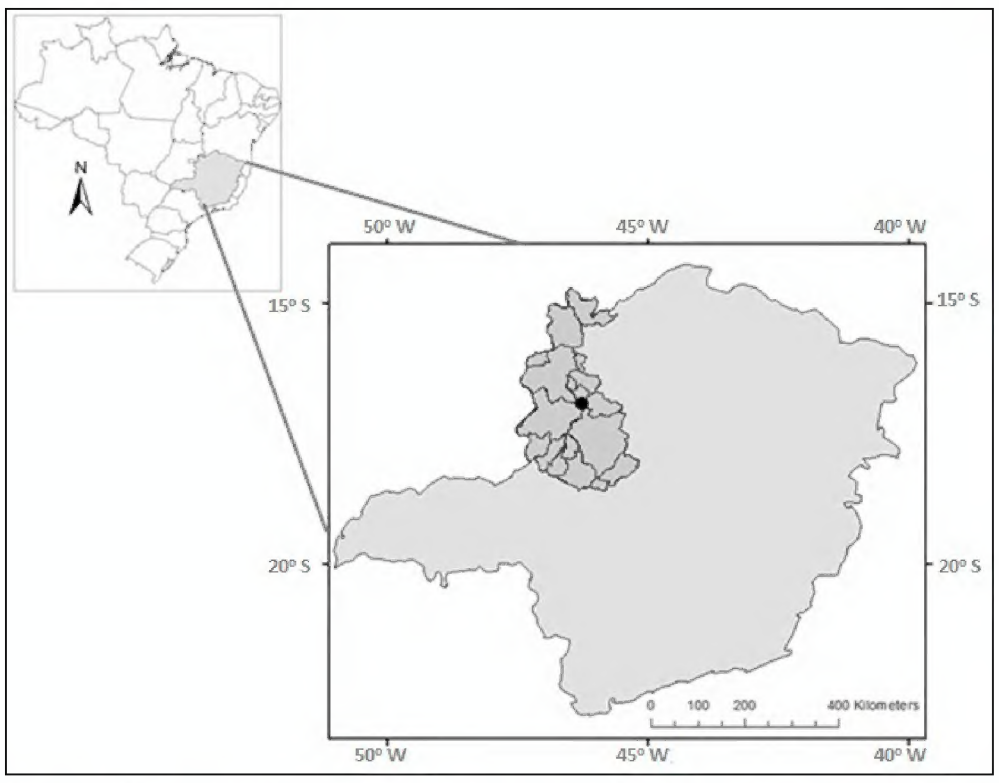

FIGURE 1. Map showing Brasilândia de Minas limits and study site (black dot) in Minas Gerais state, Brazil.

The relative abundance index of species (RAI) was calculated according to the model proposed by Eduardo and Passamani (2009): i/N, where i = number of records of each species; N = total number of records for all species. Only the species recorded in track plots were considered for RAI. To avoid overestimating abundance, footprints observed in the same day in each trail were treated as a single record. Representatives of the genus *Mazama* were not distinguished, being identified to the genus level only (*Mazama* spp.). The relatively completeness of the inventory was assessed through the inspection of the topology of cumulative curve (Voss *et al*. 2001).

RESULTS AND DISCUSSION

We registered 23 medium to large-sized mammal species during our surveys (Table 1). The order Carnivora was the most commonly observed, with nine species of five families. In 20 days of data collection by track plots, 63 records were obtained, resulting in a sampling success of 3.1 records/day.

Four species are included in the Brazilian official list of endangered species and eight are in Minas Gerais State red list (Machado *et al*. 2008 – IBAMA; COPAM/MG 2010). *Ozotocerus bezoarticus* and *Tapirus terrestris* are considered Near Threatened by COPAM/MG (2010), but do not appear in the IBAMA list. *Lontra longicaudis* and *Pecari tajacu* appear as Vulnerable in Minas Gerais state red list and four carnivores (*Leopardus braccatus*, *Leopardus pardalis*, *Puma concolor* and *Chrysocyon brachyurus*) are classified as Vulnerable species in both lists (Machado *et al*. 2008 – IBAMA; COPAM/MG 2010) and Near Threatened by the IUCN (IUCN 2010). The endangered species recorded in this study correspond to 5.8% of the Brazilian threatened species (Machado *et al*. 2008 - IBAMA), and 17.8% of Minas Gerais state red list (COPAM 2010).

Considering the footprints records, 3 species of the 16 species (*Cerdocyon thous*, *Mazama* sp. and *Dasypus novemcinctus*) presented the highest indices of relative abundance (RAI = 0.12, RAI = 0.10 and RAI = 0.09, respectively). The lowest indices (RAI = 0.01) were registered for *Eira barbara*, *Conepatus semistriatus and O. bezoarticus* (Figure 2).

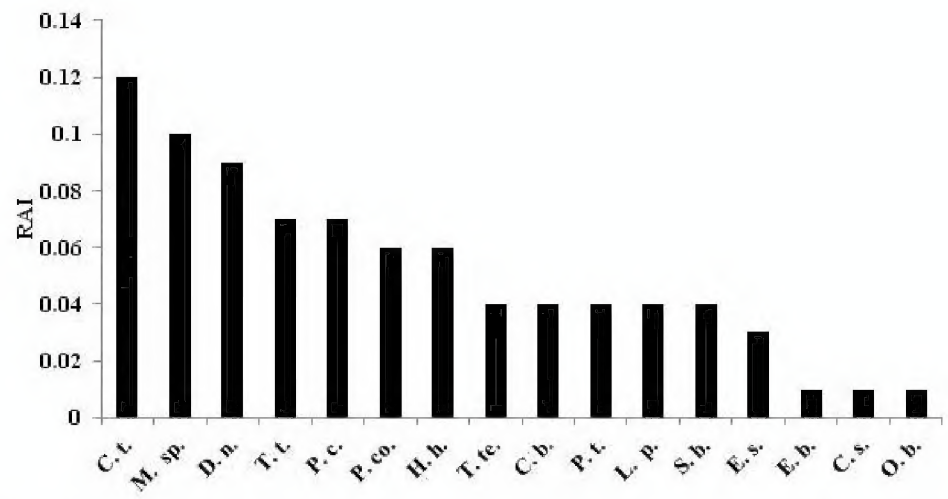

FIGURE 2. Relative abundance index (RAI) of medium and large size mammals recorded in Brasilândia de Minas, Minas Gerais state, Brazil. Abbreviations: C.t. = *Cerdocyon thous*; M.sp. = *Mazama* sp.; D.n. = *Dasypus novemcinctus*; T.t. = *Tapirus terrestris*; P.c. = *Procyon cancrivorus*; P.co. = *Puma concolor*; H.h. = *Hydrochoerus hydrochaeris*; T.te. = *Tamandua tetradactyla*; C.b. = *Chrysocyon brachyurus*; P.t. = *Pecari tajacu*; L.p. = *Leopardus pardalis*; S.b. = *Silvilagus brasiliensis*; E.s. *Euphractus sexcinctus*; E.b. = *Eira barbara*; C.s. = *Conepatus semistriatus*; O.b. = *Ozotocerus bezoarticus*.

The richness reported here for medium and large size mammals (23 species) is in accordance with other surveys carried out in cerrado areas in Brazil, which generally present between 18-29 species (Rocha and Dalponte 2006; Trolle *et al*. 2007; Moreira *et al*. 2009; Bruna *et al*. 2010). However, the topology of the species accumulation curve (Figure 3) does not show an asymptotic tendency, indicating that the inventory is not complete. Additional fieldwork with combination of different sampling methodologies (Moreira *et al*. 2008) may result in the record of more species.

Our record of species considered rare or extinct in other cerrado areas, such as *P. concolor*, *T. terrestris* and *O. bezoarticus* (see Trolle *et al*. 2007; Lyra-Jorge *et al*. 2008; Bruna *et al*. 2010), may be related to the large size of the study site (11,973 ha) which increases the probability of occurrence of suitable habitats for these species. *O. bezoarticus* seems to be an open habitat specialist whereas *P. concolor* and *T. terrestris* are habitat generalist species (Fonseca *et. al*. 1996; Reis *et al*. 2011). Some other generalist species with high adaptability to different kinds of habitat, such as *C. thous*, *D. novemcinctus* and *Mazama* sp. (Fonseca *et al*. 1996), were recorded with high abundance

index (RAI) (Figures 4 and 5).

Other species that deserves remark is *L. braccatus*, which was visually identified in two occasions by the reddish fur and the characteristic dark stripes on the fore and hind limbs (Eisenberg and Redford 1999; Reis *et al.* 2011). The presence of the species in the Northwestern region of Minas Gerais state is somewhat unexpected, but Bagno *et al.* (2004) reported its presence at Grande Sertão Veredas National Park in 1998 and Cáceres *et al.* (2007) believe that the distribution of *L. braccatus* is continuous from central and Western Brazil to central Argentina, throughout the semi-open habitats of the Brazilian cerrado.

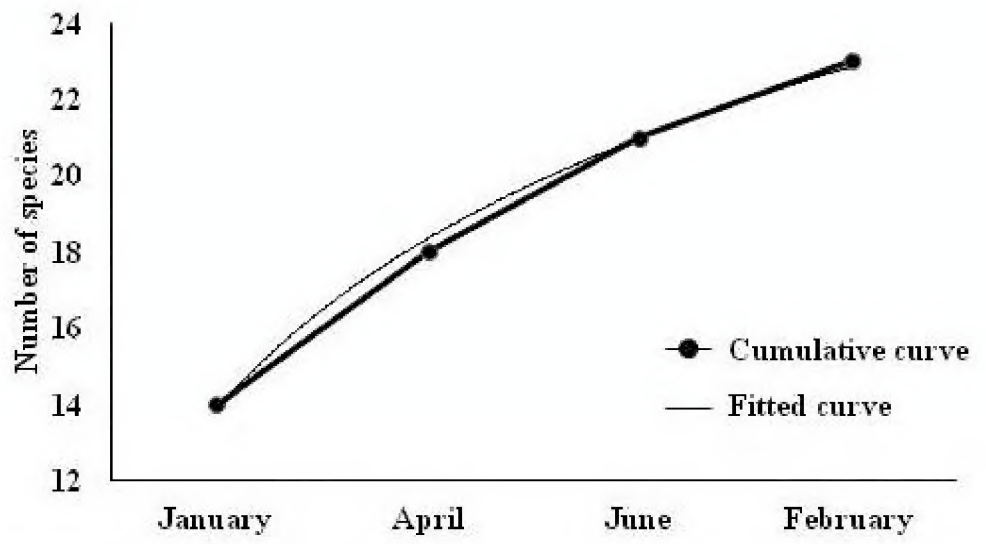

FIGURE 3. Cumulative number of species recorded per field trips during systematic survey in Brasilândia de Minas, Minas Gerais state, Brazil.

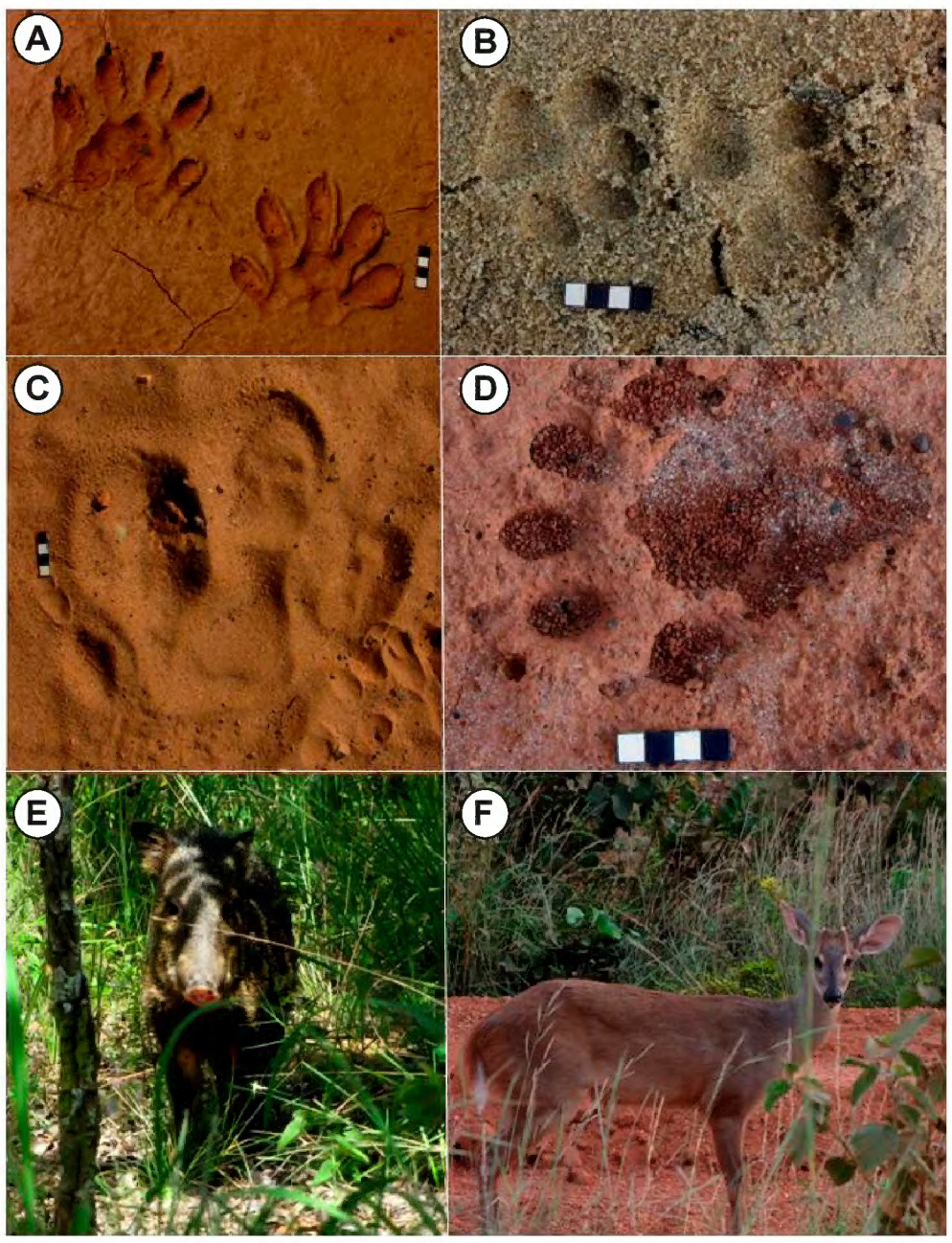

FIGURE 4. Photographic records of some of the footprints and mammals observed directly in Brasilândia de Minas, Minas Gerais state, Brazil. (A) *Procyon cancrivorus* tracks, (B) *Cerdocyon thous* tracks, (C) *Tapirus terrestris* track, (D) *Eira barbara* track, (E) *Pecari tajacu* in cerrado *strictu senso*, (F) *Mazama gouazoubira* in 'cerradão'. (Scale = 3 cm).

FIGURE 5. Photographic records of some of the footprints and mammals observed directly in Brasilândia de Minas, Minas Gerais state, Brazil. (A) *Puma concolor* tracks, (B) *Leopardus pardalis* track, (C) *Ozotocerus bezoarticus* tracks, (D) *Mazama* sp. track, (E) *Chrysocyon brachyurus* feces, (F) *Lontra logicaudis* feces. (Scale = 3 cm).

Our results support the hypothesis that many of cerrado mammal species may be able to persist in fragmented landscapes (Lyra-Jorge *et al.* 2008; Bruna *et al.* 2010). Medium and large-sized mammals in fragmented agricultural landscapes may explore the region as a whole and are not constrained to the native vegetation areas (Chiarello 2000; Lyra-Jorge *et al.* 2008). In this study, species with large home ranges such as *P. concolor*, *T. terrestris* and *P. tajacu* (Emmons and Feer 1997; Chiarello 2000) confirm their ability to use landscapes that are a mosaic of natural vegetation patches and agriculture. However, the effects of fragmentation may explain why some forest species, such as *Panthera onca*, which are considered to be more susceptible to habitat fragmentation (Chiarello 2000; Lyra-Jorge *et al.* 2008), no longer occur in the study site. The fragmentation of natural vegetation is one of the main problems affecting mammal community conservation in the cerrado (Trolle *et al.* 2007; Lessa *et al.* 2008).

In this study we present the first inventory of species richness and relative abundance by medium and large size mammals in Brasilândia de Minas, a municipality inserted in a priority area for mammal conservation in Minas Gerais state, Brazil (see Drumond *et al.* 2005). Despite the anthropogenic influence detected, the study site plays an important regional role, promoting the persistence of threatened mammal species, consequently contributing for their conservation in the cerrado biome.

Table 1. Method of record and conservation status of medium and large size mammal's taxa recorded in Brasilândia de Minas, Minas Gerais state, Brazil. *Abbreviations: F = Footprints; O = Other vestiges (burrows, feces); V = Vocalization; Vi = Visualization.

TAXON	COMMON NAME	RECORD*	CONSERVATION STATUS	
			IBAMA 2008	COPAM 2010
DIDELPHIMORPHIA				
Family Didelphidae				
Didelphis albiventris (Lund, 1840)	White-eared Opossum	Vi		
CINGULATA				
Family Dasypodidae				
Dasypus novemcinctus (Linnaeus, 1758)	Nine-banded Armadillo	F/O		
Euphractus sexcinctus (Linnaeus, 1758)	Six-banded Armadillo	F/O		
PILOSA				
Family Myrmecophagidae				
Tamandua tetractyla (Linnaeus, 1758)	Southern Tamandua	F		
PRIMATES				
Family Cebidae				
Callithrix penicillata (Linnaeus, 1758)	Black-pencilled Marmoset	V/Vi		
Family Atelidae				
Sapajus libidinosus Spix, 1823	Black-striped Capuchin	V/Vi		
CARNIVORA				
Family Felidae				
Leopardus braccatus (García-Perea, 1994)	Pampas cat	Vi	Vulnerable	Vulnerable
Leopardus pardalis (Linnaeus, 1758)	Ocelot	F	Vulnerable	Vulnerable
Puma concolor (Linnaeus 1771)	Puma	F	Vulnerable	Vulnerable
Family Canidae				
Cerdocyon thous (Linnaeus, 1766)	Crab-eating Fox	F/Vi		
Chrysocyon brachyurus (Illiger, 1815)	Maned Wolf	F/O/Vi	Vulnerable	Vulnerable
Family Mephitidae				
Conepatus semistriatus (Boddaert, 1784)	Hog-nosed Skunk	F/Vi		
Family Mustelidae				
Lontra longicaudis (Olfers, 1818)	Lobito	F/O		Vulnerable
Eira barbara (Linnaeus, 1758)	Tayra	F/Vi		
Family Procyonidae				
Procyon cancrivorus (Cuvier, 1798)	Crab-eating Racoon	F		
ARTYODACTYLA				
Family Cervidae				
Mazama sp.	Deer	F		
Mazama gouazoubira (Fischer, 1814)	Gray Brocket deer	F/Vi		
Ozotocerus bezoarticus (Linnaeus, 1758)	Pampa Deer	F		Near Threatened
Family Tayassuidae				
Pecari tajacu (Linnaeus, 1758)	Collared Peccary	F/Vi		Vulnerable
PERISSODACTYLA				
Family Tapiridae				
Tapirus terrestris (Linnaeus, 1758)	Tapir	F		Near Threatened
RODENTIA				
Family Caviidae				
Hydrochoerus hydrochaeris (Linnaeus, 1766)	Capybara	F/O		
Family Cuniculidae				
Cuniculus paca (Linnaeus, 1766)	Paca	O		
LAGOMORPHA				
Family Leporidae				
Silvilagus brasiliensis (Linnaeus, 1758)	Brazilian Rabbit	F/O		

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